

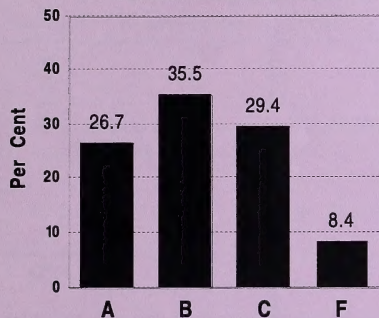
Chemistry 30

Diploma Examination Results Examiners' Report for June 1993

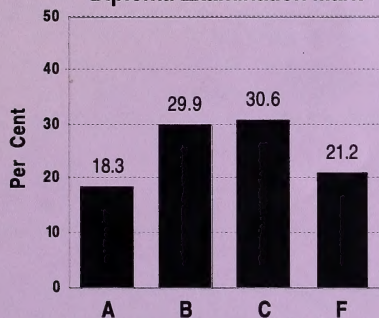
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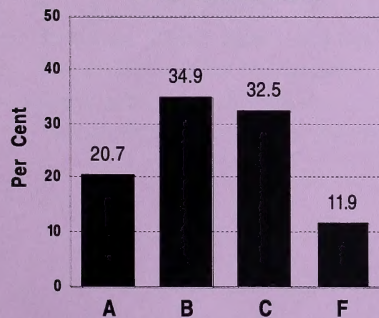
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the June 1993 administration of the Chemistry 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been mailed to schools and school jurisdiction offices. An annual provincial report containing a detailed analysis of the combined January, June, and August results is published each year.

Description of the Examination

The Chemistry 30 Diploma Examination consists of three parts: a multiple-choice section of 42 questions worth 60%, a numerical-response section of seven questions worth 10%, and a written-response section of three questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 9 166 students in Alberta who wrote the June 1993 examination.

- 88.1% of these students achieved the acceptable standard (a final course mark of 50% or higher).
- 20.7% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Overall, student achievement in Chemistry 30 was acceptable, particularly in knowledge of core concepts. However, students continued to have difficulty with laboratory-related skills and processes, and in organizing and communicating their chemistry knowledge.

Provincial Averages

- The average school-awarded mark was 68.7%.
- The average diploma examination mark was 63.1%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 66.3%.

Results and Examiners' Comments

Subtest

When analyzing detailed examination results, please bear in mind that subtest results cannot be directly compared.

Results are in average raw scores.

Machine scored: 33.6 out of 49

Course Content

- Chemical Energetics
11.2 out of 16
- Acids and Bases: 10.9 out of 16
- Oxidation-Reduction:
11.2 out of 17

Cognitive Levels

- Knowledge: 16.0 out of 20
- Comprehension and Application:
13.7 out of 23
- Higher Mental Activities:
3.8 out of 6

Written Response: 10.6 out of 21

Process Skills: 21.7 out of 36

Examination Blueprint

Each question on the examination is classified in two ways: according to the curricular content area being tested and according to the cognitive level demanded by the question. The examination blueprint illustrates the distribution of questions in June 1993 according to these classifications.

Subject Matter	Machine Scored			Written Response	Exam Emphasis
	Knowledge	Comprehension and Application	Higher Mental Activities	C/A, HMA, and Communication	
Chemical Energetics	1, 2, 4, 6, 7, 9, 10	5, 8, 11, 12, 13, 14 (1) (2)	3	2	33%
Acids and Bases	15, 16, 17, 19, 21, 24, 29	20, 22, 23, 25, 27 (3) (4)	18, 26	3	33%
Oxidation-Reduction	30, 31, 35, 36, 37, 41	32, 33, 34, 40, 42 (5) (6) (7)	28, 38, 39	1	34%
Examination Emphasis	29%	32%	9%	30%	100%

Note: Numbers in brackets () indicate the numerical-response questions.

In the table above, those questions which involve the use of science process skills from the multiple-choice section of the examination are 3, 8, 13, 21, 22, 25, 26, 29, 30, 35, 39, and 40; those from the numerical-response section are 2, 6, and 7; those from the written-response section are 1, 2, and 3.

Science process skills received an exam emphasis of 52%.

Cognitive levels received a total examination emphasis of

- Knowledge 29%
- Comprehension and Application 51%
- Higher Mental Activities 20%

This examination has a balance of question types and difficulties. It is designed so that students capable of achieving the acceptable standard will obtain a mark of 50% and students capable of achieving the standard of excellence will obtain a mark of 80%. Future examinations will continue to require students to demonstrate clarity in their thinking and an understanding of concepts by applying their knowledge to new and novel situations. Students who achieved these expectations were successful on this examination. All future diploma examinations will continue to require students to communicate their answers in a clear, concise, and organized fashion.

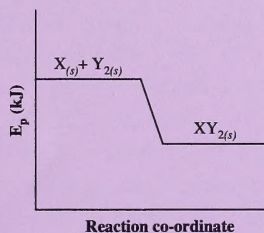
Multiple Choice

Question	Key	Difficulty*	Question	Key	Difficulty	Question	Key	Difficulty
1	D	76.7	15	A	90.3	29	A	76.1
2	D	76.6	16	B	78.3	30	D	87.8
3	C	72.0	17	D	81.5	31	A	72.4
4	A	89.7	18	C	55.0	32	B	71.7
5	D	76.9	19	A	66.9	33	A	44.4
6	C	91.4	20	B	37.7	34	B	80.4
7	A	56.1	21	A	90.6	35	D	83.8
8	B	80.4	22	C	70.7	36	A	50.1
9	B	88.8	23	D	74.3	37	A	94.8
10	C	83.4	24	C	85.4	38	C	64.3
11	B	52.3	25	B	93.2	39	D	82.4
12	D	58.8	26	A	81.9	40	C	83.8
13	C	43.5	27	D	31.6	41	B	83.0
14	A	70.2	28	A	26.1	42	B	54.3

*Difficulty—percentage of students answering the question correctly

8. The statement that best explains the data represented in the diagram at the right is that ΔH is

- A. positive and the reaction is exothermic
- B. negative and the reaction is exothermic
- C. negative and the reaction is endothermic
- D. positive and the reaction is endothermic



28. An unlabelled beaker contains a blue solution that is known to be either $\text{CuSO}_4(aq)$ or bromothymol blue. Any one of several substances could be added to this solution in order to identify it. Which of these reagents would **not** be useful in determining the contents of the beaker?

- A. $\text{Ag}_{(s)}$
- B. $\text{Pb}_{(s)}$
- C. $\text{NaOH}_{(aq)}$
- D. $\text{HCl}_{(aq)}$

The following two questions were selected for discussion because they exemplify what is required to meet the acceptable standard and the standard of excellence.

Question 8: Most students (85.2%) were able to extract information from a diagram to determine that the reaction would be exothermic, and 80.4% of all students correctly identified that the ΔH value would be negative. Of the students who answered incorrectly, 14.8% associated the diagram with an endothermic reaction. The results for this question suggest that students attaining the acceptable standard understand fundamental concepts such as endothermic/exothermic changes and can relate these concepts to numeric values.

Question 28: Only 26.1% of the students could successfully integrate concepts from acid-base chemistry with redox chemistry to answer the question correctly. Most students (60.0%) approached the question from only an acid-base perspective and incorrectly selected $\text{HCl}_{(aq)}$ (19.6%) and $\text{NaOH}_{(aq)}$ (40.4%) as reagents incapable of distinguishing between the two solutions. One reason for this may have been the question's location in the examination near the end of the acid-base section. This result suggests that many students have limited ability to integrate concepts from more than one unit and draw accurate conclusions, and that those students who do not attain the standard of excellence cannot transfer conceptual information into an empirical framework.

Numerical Response

Virtually all students correctly followed the instructions for filling in the answer sheet. Students who did not round their answers as instructed lost marks.

Question	Answer	Difficulty*
1	48.3	61.5
2	3579	39.4
3	7.38	58.0
4	12.2	18.4
5	23.2	43.1
6	13	70.7
7	2146	56.4

*Difficulty—percentage of students answering the question correctly

Detailed comments on two questions follows.

6. Given the following half-cells listed at the right, which pair will produce an electrochemical cell with an $E^\circ_{\text{net}} = 2.00 \text{ V}$?

- The cathode reagents are _____.
(Record in first column)
- The anode reagents are _____.
(Record in second column)

- $\text{Cu}_{(s)}$ with $\text{Cu}^{2+}_{(aq)}$
- $\text{Fe}_{(s)}$ with $\text{Fe}^{2+}_{(aq)}$
- $\text{Al}_{(s)}$ with $\text{Al}^{3+}_{(aq)}$
- $\text{Mg}_{(s)}$ with $\text{Mg}^{2+}_{(aq)}$

LEAVE THE THIRD AND FOURTH
COLUMNS BLANK

The average for **question 6** was 70.7%. This question discriminated well between weak and average students. Virtually all students who attained the standard of excellence were successful. The majority of the students who attained the acceptable standard (80.5%) selected appropriate reagents, and 69.7% of the students attaining the acceptable standard were able to classify the reagents. Only 54.3% of the students who did not attain the acceptable standard were able to select appropriate reagents. The chance of these students classifying the reagents successfully was no greater than that of guessing. The most common mistakes these students made were in having the oxidizing agent oxidized rather than reduced (31.0%) and in selecting $\text{Mg}_{(s)}$ with $\text{Mg}^{2+}_{(aq)}$ as one of the reagents (33.0%). These students also tried to set up two cells to produce a combined voltage of 2.00 V (4.7%).

This suggests that students achieving the acceptable standard do so because they are capable of combining tasks such as identifying appropriate reagents and identifying the process occurring at the electrodes in an electrochemical cell.

4. Assuming complete dissociation, what is the pH of the solution formed when 50.0 mL of 0.01 mol/L $\text{Ba}(\text{OH})_{2(aq)}$ are mixed with 50.0 mL of 0.01 mol/L $\text{NaOH}_{(aq)}$? (Record your answer to three digits.)

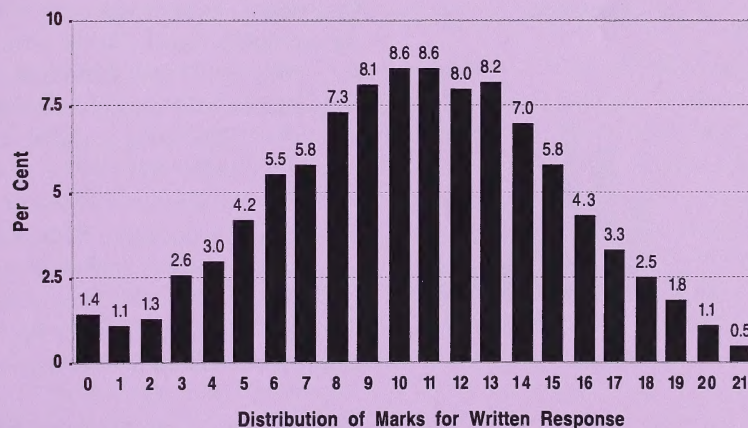
The average for **question 4** was 18.4%. This question discriminated very well between strong and fairly strong students. The question involved the addition of two bases; 8.3% of all the students did not attempt this problem. However, virtually all students attaining the standard of excellence attempted the question and 53.0% of them were successful. Very few students (4.9%) did not recognize that the resulting mixture would be basic. The most common mistake this

group made was in using 1.00 L rather than 100 mL as the final volume of the mixture. Students who attained the acceptable standard had great difficulty in answering this question, partially because only 67.6% of these students recognized that the final solution would be basic. Only 10.9% of this group was able to determine the correct answer. The most common mistakes this group made was the omission of the 2:1 ratio between the $\text{OH}^-_{(aq)}$ and the $\text{Ba}(\text{OH})_{2(aq)}$ and assuming that a neutralization reaction occurred. Students who did not attain the acceptable standard were not successful in answering this question, and only 31.0% of these students recognized that the resulting mixture would be basic. There were no common mistakes made by this group.

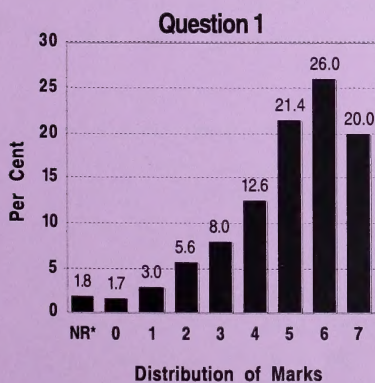
The results for this question suggest that students achieving the standard of excellence do so because they are capable of combining tasks such as recognizing when a reaction does not occur, identifying the relationship between the solute and the solution formed, and performing valid calculations.

Written Response

The standard of achievement on the written-response section was lower than expected: only half of the students (51.2%) achieved a mark of 11 or higher out of 21. However, markers noted that the quality of student writing and organization has improved since the introduction of the communications scoring criteria. The average mark on the written-response section was 50.2% of the available marks.



Question 1 was answered as well as expected. It should be noted that the intent of this question was to distinguish between students below the acceptable standard and at the acceptable standard. Students who did not attain the acceptable standard on the examination were expected to score either 1 or 2 on this question. They did this by selecting half-reactions to write a balanced net ionic equation. In addition, they were able to use appropriate methods for determining the mass of the iron in the sample and

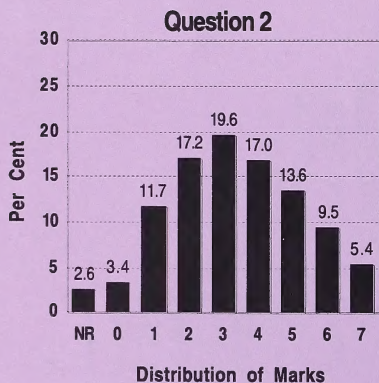


NR* - No Response

the correct number of significant digits in the final answer. The most common mistakes that this group made were omitting or inverting the mole ratio and selecting inappropriate half-reactions to write the balanced net ionic equation. Most of these students were able to select a method to prevent the corrosion of iron. They had difficulty in describing their method and were unable to explain how the method they selected prevented corrosion from occurring. Students who attained the acceptable standard were able to determine the correct net ionic equation and mole ratio. In general, these students performed the stoichiometric process well; they paid careful attention to rounding off to the proper number of significant digits and to the use of units throughout. They were able to select a method to prevent corrosion and could describe it. However, they confused the rationale for protecting iron by isolating it from the environment through electroplating/painting with the rationale for cathodic protection. As a result, they tended to offer valid statements that were not appropriate to the method they selected.

Students who attained the standard of excellence were expected to score 7 marks and they did. They wrote the correct net ionic equation and performed the necessary calculations. They selected a suitable and practical method of protecting iron and explained how this method protected the iron. Their responses were well organized and their ideas were communicated clearly with essentially no communication errors.

On this 7-mark question, the average mark was 4.91 or 70.1% of the available mark.



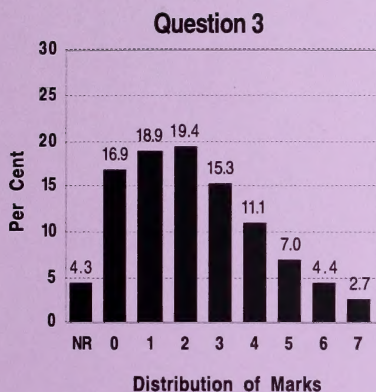
Question 2 was answered as well as expected. Students who did not attain the acceptable standard knew that a change in kinetic energy was involved but tended to recall familiar methods, $\Delta H = mc\Delta t$ or $nH = mc\Delta t$, rather than deriving a method to solve the question. These students used a variety of heat values (ΔH_f , $\Delta H_{\text{vaporization}}$) in their attempt to solve the question. They were also unable to identify the specific heat capacity of the metals as the reason for the different temperatures in the experiment. Most could not rationalize why one metal would keep water warm longer than the others and as a result probably guessed at an answer. Most of these students' responses displayed very poor mathematical skills and were poorly organized and communicated. Spelling, grammatical, significant digit, and unit errors abounded in their responses.

Students who attained the acceptable standard on the examination correctly determined a method to calculate the final temperature of iron. However, most students were not able to solve for the method they used. Generally, they had difficulty in defining Δt in terms of t_{initial} and t_{final} . They were able to identify specific heat capacity as the reason for different results in the experiment but tended to use incomplete terminology in their response. Terms such as capacity, heat capacity, specific heat, and specific capacity were not uncommon in their responses. They accurately identified aluminum as the best metal to make a cooking pot but failed to provide an

accurate rational for their selection. The majority of the responses showed evidence of a good understanding of significant digits and units, and were well organized and easy to follow.

Students who attained the standard of excellence clearly communicated their answers. They had no difficulty in determining the relationship required to determine the final temperature of iron, nor did they have any difficulty in explaining the relationship and the outcomes or in calculating accurate values. Most responses showed good communication and organizational skills.

On this 7-mark question, the average mark was 3.36 or 48.0% of the available mark.



Question 3 was not answered as well as expected. Students who did not meet the acceptable standard were unable to correctly address this question. These students described the shape of the graph or gave information about the titration rather than using information from the graph to draw conclusions about the acids' characteristics. These students confused strength and concentration and used these terms as synonyms. They were able to determine the initial hydronium ion concentration and showed familiarity with pH curves, but they did not attempt any of the other quantitative aspects of the question. These students gave properties related to any acid, rather than information drawn from the graph of the titration curve. These students also had difficulty expressing themselves. As a result, markers had to interpret their responses, which in many cases contained errors in the conventions of the communication used.

Students who attained the acceptable standard correctly identified the acid as a weak monoprotic acid and showed good analytic skills. However, most of these students had difficulty substantiating their classification of the acid and in distinguishing between strength and concentration; as a result their answers tended to ramble. These students were successful in determining the concentration of the acidic solution but did not recognize that the per cent reaction or K_a of the acid could be determined from the information available to them from the graph. They also tended to give more than the requested four characteristics. These students were able to communicate their ideas well enough to the markers so that little, if any, interpretation was required.

Students who attained the standard of excellence displayed good analytical and computational skills. They identified the acid as being a monoprotic weak acid and determined both the concentration and per cent reaction of the acid. These students were able to substantiate their answers effectively. They presented their answers in a concise, organized fashion and expressed themselves clearly so that no interpretation was required.

All students displayed a lack of knowledge concerning the correct way to spell “pH”. Spellings of Ph, ph, or PH were not acceptable and students using these terms did not achieve full marks for communication.

On this 7-mark question, the average mark was 2.28 or 32.6% of the available mark.

For further information, contact Don Loerke or Phill Campbell at the Student Evaluation Branch, 427-0010.